07.1 PARTICLES.KO.2022-23

States of Matter

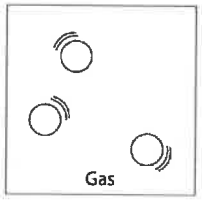
Materials come in three different forms: solids, liquids and gases. These are called the Three States of Matter and they are made of **particles**.



Particle: an incredibly small, round object that all materials (matter) are made from. Single particles are also called atoms (which we will use more often as we get closer to GCSE.
Spacing: the distance that is between next door neighbour particles or atoms.
Arrangement: a description of how the particles or atoms are laid out in the space they are in.
Movement: a description of how much the particles and/or how fast they are moving.
Force: the attraction that each particle or atom feels to stay close to its next-door neighbour particle or atom.

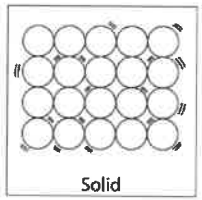
Particles in gases

The particles in a gas have the **most energy**.
There are **very weak forces** of attraction between the particles.
The particles are **far apart** and free to move quickly in all directions.
The particles **move fast**, and so collide with each other and the container.
Gases don't keep a definite shape or volume and **will always expand** to fill any container.
Gases can be **compressed easily** because there's a lot of free space between the particles.
Gases all have **very low densities**, because there are not many particles in a large volume. The particles in gases are far apart and have **lots of energy**.



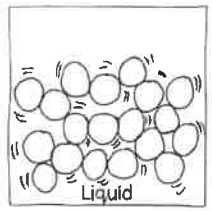
Particles in solids

The particles in a solid have the **least energy**.
There are **strong forces** of attraction between particles.
The particles are **held closely** in fixed positions in a very regular arrangement. But they do **vibrate** backwards and forwards around a fixed point.
The particles don't move from their positions, so all solids keep a **definite shape** and **volume**, and **can't flow** like liquids.
Solids **can't** easily **be compressed** because the particles are already packed very closely together.
Solids are **usually dense**, as there are lots of particles in a small volume.



Particles in liquids

The particles in a liquid have **more energy**.
There are **some forces** of attraction between the particles.
The particles are **close, but free to move** past each other — and they do stick together.
The particles are constantly moving in all directions.
Liquids **don't keep a definite shape** and can form puddles.
They flow and fill the bottom of a container.
They **keep the same volume**.
Liquids **won't compress** easily because the particles are packed closely together.
Liquids are **quite dense**, as there are quite a lot of particles in a small volume.



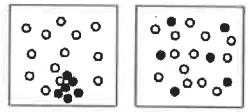
Diffusion

Diffusion is the name we use in science when we are talking about particles **moving from one location** in a container to another. In other words, it is just particles **spreading out**.

Particles tend to spread out — this is called **diffusion**.

Smells spreading out
A smell spreads slowly through a room. The smell particles move from an area of **high concentration** (i.e. where there are lots of them) to an area of **low concentration** (where there's only a few of them).

Diffusion is **slow** because the smell particles keep bumping into air particles, which stops them making forward progress and often sends them off in a completely different direction.



07.1 PARTICLES.KO.2022-23

Physical Changes

Sometimes solids change into liquids and liquids change into gases. Gases can turn back into liquids and liquids can turn back into solids.
These changes **do not affect** the **number** or type of **particles**, just their arrangement or how fast they are moving (**'energy'**).

Physical changes can be changes of state i.e. changing from one state of matter to another.

Melting Ice

Water ice cubes melting is a change of state (from solid to liquid) and it is also an example of a physical change. A change of state does not involve a change in mass, only a **change in energy.**

Learn these names

Melting: solid → liquid
Freezing: liquid → solid
Evaporating: liquid → gas
Condensing: gas → liquid
Sublimation: solid → gas

Density

Definition of Density: density is the **mass per unit volume of a substance** (which means it it is a number that tells you how compact a material is for the space it takes up).
Units: g/cm³ or kg/m³.
Symbol: ρ (not a letter "p") spelled "rho" and pronounced "row as in 'I row the boat'".
Examples: lead is very dense and a small amount of it feels heavy (has a lot of mass). Oxygen is a gas and is the opposite: it is not very heavy even when there is a large volume of it).

Equation linking density, mass and volume

$$density = \frac{mass}{volume} \quad \rho = \frac{m}{V}$$

also $V = \frac{m}{\rho}$ **and** $m = \rho \times V$

The link between density and floating or sinking in water. Water has a density of 1g/cm³ or 1000 kg/m³. If any substance has a density greater than 1 it will sink; less than or equal to 1 means it will float

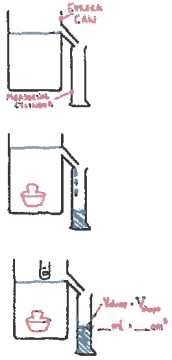
Measuring Density

Regular objects

1. Measure the length, width, height.
2. Multiply to get volume.
3. Measure mass with a balance.
4. Calculate density = mass ÷ volume".

Irregular objects

1. Measure the mass of the object with a balance.
2. Fill a eureka can with some water past its spout.
3. Let excess water run out.
4. Submerge the object under the water.
5. Measure all the water that comes out of the spout with a measuring cylinder.
6. This is the object's volume.
7. Calculate **density = mass ÷ Volume**

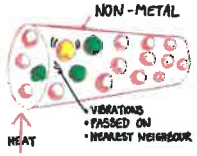


Conduction

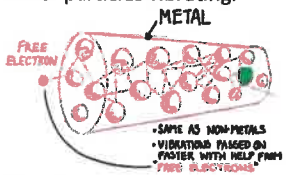
Definition of Conduction: Conduction is the movement of heat energy from a hotter region through a solid to a colder region.

Conduction theory:

Conduction in non-metals happens by **particles** simply **vibrating** and starting their **neighbouring particles** vibrating **because** they are touching.



Conduction in metals happens in two ways. The **first** way is just like non-metals. The **second** way is that tiny particles in the metal called **free electrons** move through the gaps in between particles to start other particles vibrating.



Good conductors are solids and the **best** conductors are **metals**..

Convection

Convection occurs **only** in **liquids** and **gases**. The particles in liquids and gases are able to move.
When you heat a region of a gas or liquid, the **particles move faster** and the space between individual particles increases. This causes the density of the region being heated to decrease. Because liquids and gases can flow, the **warmer** and less dense region will **rise** above denser, cooler regions. If there is a constant heat source, a convection current can be created.

Domestic room heaters ('radiators')

The radiator gets hot from hot water passing through it.
The metal touches the air around it and heats it (conduction).
The hotter air rises and is replaced by cooler air, which gets heated and rises, which is replaced by cooler water and so on.
In this way large amounts of air can be heated for use by families in homes.



07.2 CELLS.KO.2022-23

Life processes

All living things have seven things in common. We call these **life processes**.
There are 7 in total and their initials spell **Mrs Gren.**

Movement
All living things move - to find food, escape predators or find better growing conditions.
Plants grow towards things like light.
Reproduction
All living things make more living things of the same type - making new generations of a species.
Sensitivity
All living things can detect changes in the surroundings such as changes in light.
Growth
All living things grow.
Respiration
All living things get energy from food. Many use oxygen to do this.
Excretion
All living things get rid of waste - including carbon dioxide from respiration.
Nutrition
All living things take in and using food as a supply of energy.

Animal and plant cells

Another word for 'living things' is **organism**.
Organisms (animals and/or plants) are made of **cells**.

Animal & Plant Cells

1) Nucleus:
This controls what the cell does.
2) Cytoplasm:
This is a jelly-like stuff where most chemical reactions happen.
3) Cell Membrane
This is a thin skin around the cell. It holds the cell together and also controls what goes in and out.
4) Mitochondria:
These are tiny structures inside the cell where most of the reactions for aerobic respiration take place. Respiration is the chemical reaction that releases energy for the cell.

Plant cells also have

1) Cell Wall
A rigid outer coating made of cellulose which gives support to the cell.
2) Vacuole
This is filled with cell sap which is a weak solution of sugar and salts.
3) Chloroplasts
These contain chlorophyll used for photosynthesis. Photosynthesis makes food for the plant.

The microscope

A **microscope** is used for looking at objects that are too small to see with the naked eye. The lenses in the microscope **magnify** objects (make them look bigger) so that you can see them.

Magnification

You calculate the magnification like this:
magnification of the eyepiece lens by the magnification of the objective lens.

Example

Your eyepiece lens is **x4**
Your objective lens is **x10**
Your overall magnification is:

$$4 \times 10 = \times 40$$

In other words, what you see is forty (40) times bigger than it is in real life.

Onion Slides

1. Cut a window through several layers



2. Peel off inner layers



3. Place inner layer on slide





4. Add 2-3 drops of iodine





5. Gently lower cover slip

6. Put a drop of water by coverslip

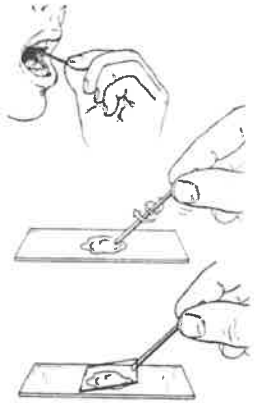
7. Drag water under coverslip by touching with tissue



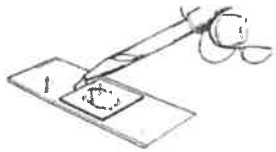
8. Look at slide of plant with microscope on x4

Cheek Cells

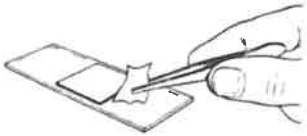
Gently scrape inside mouth with cotton wool bud.
Stir scrapings on slide with a drop of water.
Lower coverslip and avoid trapped air bubbles.



Add two drops methyl blue stain.



Tidy up.



View under microscope.

07.2 CELLS.KO.2022-23

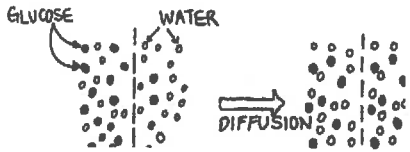
Diffusion

All cells need things like glucose (sugar) and oxygen to survive. They also need to get rid of waste products, like carbon dioxide. These materials all move into or out of cells by a process called **diffusion**.

Diffusion...

...is where a substance moves from a place where there's lots of it to a place where there's less of it.

Just like **glucose** in this diagram...

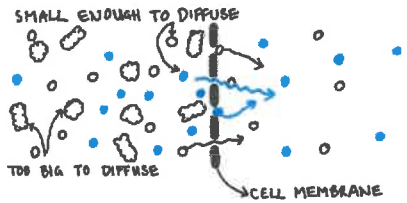


Cell Membranes...

Hold cell together but let chemicals in and out as well.

Substances go through membrane by diffusion.

Only small particles can diffuse through the membrane. Bigger particles like starch and proteins can't fit through the membrane.



Specialised cells

The cells in the animals and plants must do many different jobs.

For special jobs, cells have features that only it has. Cells that do a specialised job are called **specialised cells**.

Sperm cells

- The function (job) of a sperm is basically to get the male DNA to the female DNA.
- It has a **long tail** and a **streamlined** head to help it swim to the egg.
- There are a lot of **mitochondria** in the cell to provide the energy needed.
- It also carries **enzymes** in its head to digest through the egg cell membrane.

Nerve cells

- Nerve cells are specialised for rapid signalling
- The function of nerve cells is to carry **electrical signals** from one part of the body to another.
- These cells are **long** and look like branches connecting to other nerves at heir ends.
- Form a **network** throughout the body.

Root hair cells...

- ... in plants are specialised for absorbing water and minerals
- Are on surface of plant roots, which grow into long "hairs" that stick out into the soil.
- Has a big surface area for absorbing water and mineral ions from the soil.

Unicellular

Some organisms aren't billions of cells, they're just one (1).

In Latin, one cell is **'uni' 'cellular'**.

Bacteria...

- ...are a few thousandths of a millimetre.
- They do not have a nucleus.
- But they may have a tail (flagellum) that can spin, moving the cell along.

Protozoa...

- ...live in water or in damp places.
- The amoeba is an example. Although it is just one cell, it has adaptations that let it behave a bit like an animal.

Yeast...

- ... are unicellular fungi (mushrooms also belong to the fungi family).
- They are used by brewers and winemakers because they change sugar into alcohol
- They are used by bakers because they can produce carbon dioxide to make bread to rise.

Multicellular

Large organisms contain billions of cells, some of which work together.

The bigger the animal gets the more organisation the cells have.

Tissue...

...a group of **similar cells** come together to make a tissue. The cells all do the same sort of job.

Example

Muscle cells in your bicep (big arm muscle at the front) all work together in a tissue.

Organ...

An organ is a group of different tissues that work together..

Example

There are many tissue in your heart (an organ): muscle tissue, nerve tissue, tendon tissue, fat tissue.

Organ system...

...a group of organs work together.

Example

Your mouth, stomach, large and small intestine, liver and pancreas work together to help you get nutrients out of food.

Organ Systems...

You are a **multicellular organism** - a living thing with trillions of cells. You have **several organ systems.**

Example

You have a circulatory system, a nervous system, a digestive system, a skeletal system and a muscular system.

07.3 ENERGY.KO.2022-23

Fuels

A fuel is a substance that contains a store of chemical energy or nuclear energy.
We use this energy released from the fuels to generate electricity in power stations, which can then be transferred around to homes, schools, hospitals and offices.
Some fuels are also used to make materials like plastic, grease, cosmetics and tarmac.



Non-renewables or 'Finite'

Non-Renewable or **Finite** fuels cannot be replaced at the rate humans are using them, so eventually we are going to run out.

Example

Coal takes about 220 million years to form.
The coal we use today was formed millions of human lifetimes ago.
Once we use that coal, we won't be alive when new coal is available.



Coal

When plants died millions of years ago, they became buried in mud. This stopped them rotting in the normal way.
Over millions of years more and more layers of mud squashed them together.
With the heat produced from inside the earth, the mud turned into rock and the remains of the plants turned into what we call coal.

Coal is bad

Produces pollution
Produces CO_2 which contributes to global warming and climate change.

Coal is good

There is enough coal to satisfy what we need ***for now.***
Electricity made by burning coal is reliable.



Oil & Gas

When animals and plants that live in the sea die, the sink to the bottom of the sea.
Over millions of years layers of mud & sand fell on top of them and squashed them together.
The mud & sand turn into sludgy liquid and gas which is trapped between the rock. We call these oil and gas.

Oil & gas are bad

Produces pollution
Produces CO_2 which contributes to global warming and climate change.
Oil is such a useful product in modern life but could be deemed a waste, just using it to make electricity.

Oil & Gas are good

There is enough oil and gas to satisfy what we need ***for now.***
Electricity made by burning oil and gas is reliable.



Nuclear

Certain rocks in the ground constantly give off energy.
This energy does not come from squashed plants and animals (like coal, oil and gas) but the rocks do run out if they all get used up.
For this reason, nuclear fuel is called a non-renewable energy source.
Nuclear energy does not require burning in electricity power stations, but it still produces heat.

Nuclear is bad

Produces very dangerous toxic waste that lasts for thousands of human lifetimes. We still don't know how to deal with it safely for this long a time.

Nuclear is good

Nuclear fuel doesn't make CO_2, so it doesn't contribute to global warming and climate change.



07.3 ENERGY.KO.2022-23

Renewables

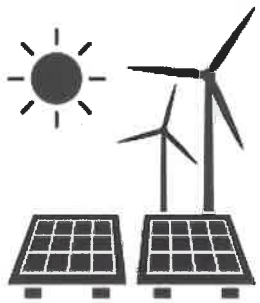
As we are slowly running out of fossil fuels, we need other ways of making electricity and satisfying our fuel needs.
A lot of renewable energy resources rely on nature or the weather which means they are not available to use all the time.

Advantages

- The resources are not depleted (used up)
- They do not damage the planet by producing pollutants
- They are low maintenance and do not required humans to operate them.

Disadvantages

- Can be unreliable as they depend on the weather
- They are expensive to build
- They do not produce as much power as non-renewable.



Solar

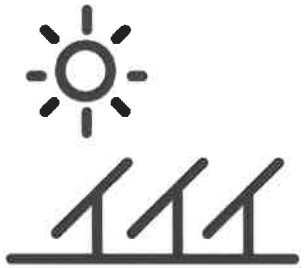
Special materials turn sunlight straight into electricity or can use sunlight to heat water.

Advantages

- Is renewable.
- Cheap.
- Doesn't pollute.
- No CO_2.

Disadvantages

- Only works when it's sunny.
- Only works where it's sunny.
- Not a very concentrated source of energy.



Wind

Wind turns special windmills called turbines that generate electricity.

Advantages

- Is renewable.
- Cheap.
- Doesn't pollute.
- No CO_2.
- UK has lots of wind.

Disadvantages

- Only works when it's windy.
- Turbines must be turned off when it's too windy.
- Not a very concentrated source of energy.



Water

The up-and-down motion of sea waves is used to turn water turbines to make electricity.

Advantages

- Is renewable.
- Doesn't pollute.
- No CO_2.
- UK has lots of sea waves.

Disadvantages

- Need huge numbers that take up a lot of space in the sea.
- Not a very concentrated source of energy.
- Very challenging engineering to build them.



Geothermal

Hot rocks in the ground have cold water pumped down to them. This water is allowed back up when it is very hot.
Steam used to heat homes and run electricity power stations.

Advantages

- Cheap.
- Free.
- Doesn't pollute.
- No CO_2.

Disadvantages

- Only works where there are hot rocks near the Earth's surface (not the UK so much).



07.3 ENERGY.KO.2022-23

Hydro electric

In mountainous places, lakes high up have holes drilled in the bottom to let water out through pipes.
The water moves very fast and turns electricity generating turbines.

Advantages

- Cheap to run.
- Free.
- Doesn't pollute.
- No CO_2.

Disadvantages

- Expensive to build.
- Only works where there are mountainous lakes.



Types of energy

There are many types or forms of energy. Whenever something happens energy gets transferred from one form into another.
By transferred we mean that it has changed from one type of energy to another.
Some types of energy are called energy stores – the energy just sits in an object or place until something happens.

Conservation of energy

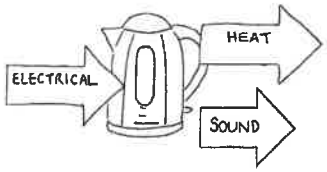
Energy cannot be created or destroyed, only transferred.
Energy is measured in joules, J.

Forms of energy

Magnetic
Kinetic
Heat (Thermal)
Light
Gravitational Potential
Chemical
Sound
Elastic
Electrical
Nuclear

Energy Transfer Diagrams

We can represent using diagrams the energy transfers that take place during some process, whether that be turning on a torch or you are sliding down a slide.
We know that the energy we put into something must be the same as the amount of energy that comes out.

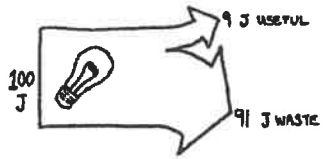


Waste & Useful Energy

Humans have made machines and devices that do useful energy transfers for us.
Unfortunately, we are not able to make devices that transfer all the energy we put into a device into the useful energy we want – there is always some waste energy.
Input, useful and waste energy are easily seen on a ...

Sankey Diagram

These diagrams show the input energy on the left.
They show the waste and useful energy on the right.
The numbers on the right must add up to the umbers on the left.



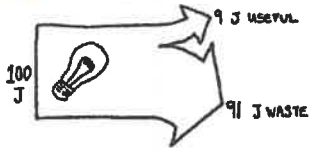
Efficiency

Efficiency is a number.
The bigger the number the better a device is at transferring energy usefully.
The lower the number the less useful a device is at transferring energy.

Formula

$$\text{Efficiency} = \frac{\text{Useful energy}}{\text{Input energy}}$$

Example



$$\text{Efficiency} = \frac{9}{100} = 0.09$$

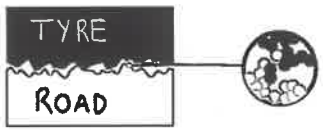
An efficiency of 0.09 is not very good.
This lightbulb is not efficient.
This light bulb wastes too much energy.

07.4 FORCES.KO.2022-23. 2022-23

Friction

Rough surfaces **interlock** and when one moves, the jagged edge of the other causes an **equal** and **opposite force** to happen.
Friction tries to stop objects sliding past each other.

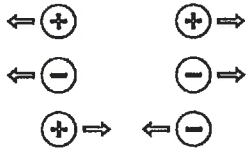
Friction stops you falling over but slows you down when you try to move.
Friction **always** acts in the **opposite direction** to whichever way you are trying to go.
If you are going to move, it's the force you need to overcome when pushing an object out of the way.
Sometimes it is **helpful**, sometimes it **slows** you down.
Friction always **wastes energy**.



Static electricity

Atoms have 3 particles in them: **Protons** and **neutrons** make up the middle part of an atom (called the nucleus). **Electrons** move about in the space around the nucleus.
- A **proton** has a **positive** charge.
- An **electron** has an equal **negative** charge.
- A neutron is neutral (which does nothing in electricity, so we'll ignore from here).

Atoms have equal numbers of electrons (-) and protons (+) but you can move the electrons around by using **friction**.
Adding electrons to an atom makes the atom **negative**.
Removing electrons from an atom makes it **positive**.
The object that gains electrons becomes negatively charged. The object that loses electrons is left with an equal but positive charge.
Like charges **repel**.
Unlike charges **attract**.



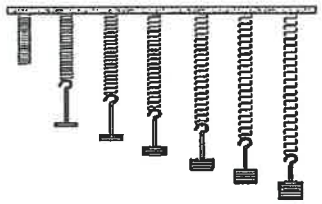
Hooke's Law

If a spring is **pulled** it **stretches**.
If it goes back to normal size after the pull has gone we say the spring is behaving **elastically**.
Springs were studied in the 17th century by a person called **Hooke**. He noticed something:
The amount it stretches (the **extension**, e), is directly **proportional** to the **force** applied, F.
In other words, the amount it stretches doubles if you pull it 2x as much.
The amount it stretches triples if you pull it 3x as much.
The amount it stretches quadruples (4x) if you pull it 4x as much.

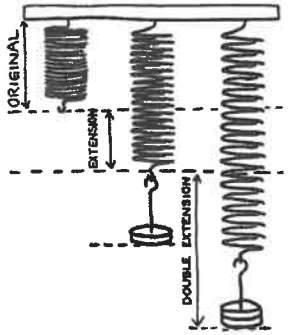
Some objects obey Hooke's Law, e.g. springs. But it only applies up to a certain force.

$F = k \times e$

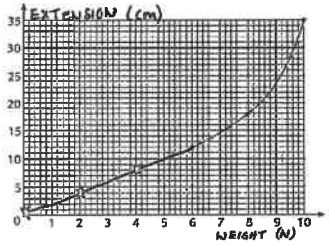
k is the spring constant
e is the extension



Hooke's Law



1. Measure the length of the spring.
2. Add a weight. Write size of weight down
3. Measure the new longer length.
4. Calculate New length – original length. Write this number down.
5. Do steps 1-4 with six different weights (7 in total).
6. Plot a scatter graph of weight (bottom axis) against extension (vertical axis). Like **this**



5 Things forces do

Forces can **start something moving** or speed it up. Like kicking a football. To start something moving a push force must be larger than the resisting forces like friction.

Slow down moving objects or stop moving objects. Air drag or air resistance often slows down cars and lorries on the motorway.

Change the direction that something is going in. Like hitting a ball with a racquet or bat. The force of gravity makes objects travelling upwards stop and come back down again.

Turn or **rotate** an object. We use a pushing or pulling force to turn spanners so that they can undo nuts and bolts.

Change the shape of an object. Every time you twist a sponge or towel, compress or stretch a spring or bend an object you are using a pushing or pulling force.

07.4 FORCES.KO.2022-23. 2022-23

Contact forces

Forces are **pushes** or **pulls** that happen when **two objects interact** (do something to each other).
Forces can't be seen, but the effects of a force can be seen (what a force does can be seen).

Forces are measured in newtons, N, in the same way that distance is measured in metres, m.

When a **force happens**, sometimes the objects involved (the objects interacting) need to be **touching**. This is always what happens when you use a chair or stool to sit on: the chair provides a **contact force** upwards to support you.

The following are all names of contact forces:

Friction
Drag
Reaction
Upthrust

Non-contact forces

Some objects **don't need to touch** to interact though. The gravitational pull between planets forces between magnets and forces due to static electricity are all non-contact forces.

The following are all names of **non-contact** forces:

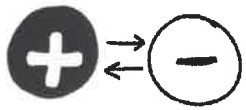
Gravitational forces.



Magnetic forces.



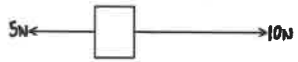
Electrostatic forces.



Force diagrams

When we want to show the **size** of a force and the **direction** that is going in, we use **arrows**. When we combine all the forces that might be happening into a single picture, we call the picture a **force diagram**.

If the forces are in **opposite** directions, **subtract**.



If they're acting in the **same** direction, **add**.



Balanced forces

In force diagrams the forces are **balanced** (when they are the same size as each other but in different directions.) or **unbalanced** (not the same size as each other when in opposite directions).

Movement with balanced forces.

If the forces on an object are **balanced** the object will **stay** doing **whatever it is doing**.

Unbalanced forces

In force diagrams the forces are **unbalanced** when they are the **not the same size** as each other in **different** directions.

Movement with unbalanced forces.

If the forces on an object are **unbalanced** the object will **speed up** (accelerate) or **get slower** (decelerate) or change direction.

07.5 ATOMS.KO.2022-23

Compounds

When two or more atoms **react** they form **chemical compounds**. The atoms are held together by **chemical bonds**.

The new **compounds** produced have **different properties** to the elements they are made from.
An example of this is the reaction of **iron** and **sulfur**.
Word equation: **iron + sulfur → iron sulphide**

Symbol equation: $Fe_{(s)} + S_{(s)} \rightarrow FeS_{(s)}$

Particle diagram: 

The iron is **magnetic** but the **iron sulfide** is **not magnetic**.

Naming Compounds
Rule 1: When **two** different elements **(a metal and a non-metal)** combine the ending is usually **"something -ide"**.
For example: Sodium and chlor**ine** give sodium chlor**IDE**
Magnesium and ox**ygen** give magnesium ox**IDE**
Potassium and sulf**ur** give potassium sulf**IDE**
Rule 2: When **three or more different elements** combine – and **one of them is oxygen** – then ending will usually be **"something -ate"**
For example: Calcium, carbon and **oxygen** give calcium carbon**ATE**
Zinc, sulfur and **oxygen** give zinc sulf**ATE**

Chemical Reactions

You can have chemical or physical reactions.

Chemical Reactions:
see **gases** given off- hear fizzing and see bubbles
colour changes
precipitates(solids) forming
temperature changes

Physical Reactions:
Melting- when a substance to changes from a **solid** to a **liquid**
Evaporating- when a substance changes from a **liquid** to a **gas**
Condensing- when a substance changes from a **gas** to a **liquid**
Freezing- when a substance changes from a **liquid** to a **solid**
Sublimation- when a **solid** changes to a **gas** with no **liquid phase**.

During **chemical reactions** the **bonds** are **broken** and **made** as the **reactants** change into the **products**.
The **mass** is **conserved** as the **total number of atoms** is the **same at the end and the start of the reaction.**

When writing out **chemical reactions** we use a **chemical equation**. In these the **reactants** go on the **left hand side** of **an arrow** and the **products** go on the **right hand side** of the arrow.
Word equations are important because they allow us to explain the changes that occur in a chemical reaction without **using long sentences**.
For example, when **iron** metal filings are heated strongly with yellow powder and **sulfur** the reactants glow bright red. The chemical reaction produces a black solid compound called **iron sulfide**.

The word equation is:
iron + sulfur →iron sulfide

07.5 ATOMS.KO.2022-23

Atoms, Elements and Compounds

Everything is made of **atoms**. They are **small particles** and cannot be seen directly.
John Dalton was the first modern scientist to try to explain atoms.
According to the **Dalton model**:

- All **matter** is made of **atoms**
- There are **different** types of atom
- Each **element** contains a different type of **atom**
- Atoms are **solid spheres** and the **smallest** type of matter

Elements:
An **element** is a substance which contains **only one** type of atom

Copper Magnesium Sodium Hydrogen Oxygen



Each element only has **one** type of atom.
There are currently **118** different elements (some natural elements and some manufactured).

Compounds:
A **compound** is formed when **2 or more different atoms** are **chemically bonded** to each other.

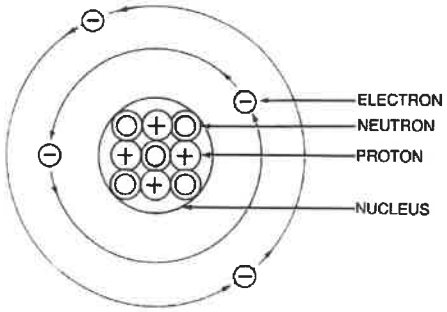


This is a diagram of sodium chloride showing the different elements **bonded** together.

Atoms

Ideas about atoms **developed** over time.
Scientists made **observations** and carried out **experiments** and proposed **models**.

Atoms were found to be made of **smaller particles** called **protons, electrons**, and **neutrons. Protons** and **neutrons** are found in the **centre** of the atom. This is called the **nucleus** of the **atom**. The **electrons** go around the **nucleus** in **orbits**. These '**orbits**' are called **energy levels** or **electron shells**.



Different atoms have **different numbers** of **protons, neutrons** and **electrons**. You can say how many by using the **Periodic Table**. The **atomic (proton) number** tells you the **number of protons, the number of electrons** will be the **same**. The **relative atomic mass** tells you the **protons and neutrons added together.** If you **take the atomic number away from the relative atomic mass** then you can get the **number of neutrons.**
Elements have **different chemical reactions** according to the **number of electrons** and **energy levels** they have.

Metals and Non-metals

Most **elements** are **metals. Metals** and **non-metals** have specific **properties.**

Metals
Good conducters of **electricity & heat**
Strong and **tough**
Shiny when polished
Sonorous
Malleable
Ductile
High melting and **boiling point**
High density
Can form **alloys**
Some are **magnetic**

Non-metals
Poor conducters of **electricity & heat**
Not strong or **hard-wearing**
Dull
Brittle
Low melting and **boiling point**
Low density
Non-magnetic

There are **exceptions** to these **properties** and they apply to most **metals** and **non-metals.**

07.6 MIXTURES.KO.2022-23

Mixtures

A **mixture** consists of two or more **elements** or **compounds** not chemically combined. The chemical properties of each substance in the **mixture** stay the same.
Mixtures can be separated by physical processes such as **filtration, crystallisation, simple distillation, fractional distillation,** and **chromatography.**

Pure

- Contains only one type particle (atom or molecule).
- Has a clear melting point (temperature).



Impure

- Impure is another word for a mixture.
- Melting point is lower and it melts over a temperature range.



solutions

Solute: This is the substance that will be dissolved in a solution.

Solvent: This is the liquid that does the dissolving.

Solution: This is the mixture of the solvent and the solute.

Soluble: If a substance dissolves in a solvent.

Insoluble: If a substance does not dissolve in a solvent.

Solubility: A measure of how much solute will dissolve in a solvent. Can be affected by temperature and pressure.

Saturated: This is the limit to the amount of solute that can dissolve in the solvent. At saturation point, no more solute can dissolve in the solvent.

Conservation of mass: "The total mass of the reaction is the same as the total mass of the products"

Separating Mixtures

Filtration

This is used to separate **soluble** substances from **insoluble** substances.



Filtration uses a **filter funnel** and **filter paper** to collect the **insoluble** substance while the **soluble** substance passes through.

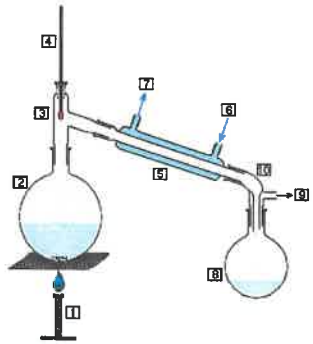
Crystallisation

This method removes a **soluble** substance from the **solvent**. The **solution** is placed in an **evaporating basin** and most of the liquid is removed by heating.



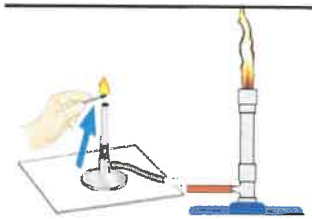
Simple Distillation

This method separates a **mixture** of two liquids with different **boiling points** like ethanol and water or separates a liquid from the **solution** such as water from sea water.



The **mixture** is heated (1) until one of the substances reaches its **boiling point** and **evaporates**. It reaches the cooler **condenser** (5) and **condenses** back into a liquid. The other liquid or **solute** will remain in the original flask.
2 and 8 = round bottom flasks
7 = water out
6 = water in
3 = thermometer

Safety when heating



1. Making sure that the Bunsen is plugged into the gas tap through the gas hose.
2. Ensure the airhole is closed.
3. Turning on the gas tap to allow gas to flow through to the Bunsen burner
4. Holding a lighted splint 2cm above the Bunsen, ignite the gas flowing into the Bunsen
5. Flame will be yellow. Open airhole to gain blue flames when required.

A hazard is anything that could cause harm.

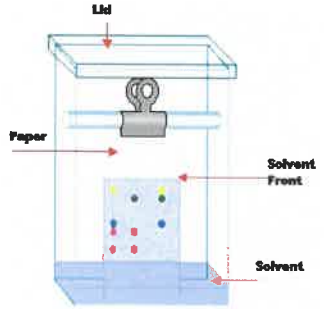
A risk is the chance that the hazard will cause harm.

Goggles must be worn when heating substances.

07.6 MIXTURES.KO.2022-23

Chromatography

This technique is used to separate **mixtures** of pigments or dyes.



Chemicals which are the same will produce spots at the same place. The position of the spot depends on how **soluble** the chemical is in the **solvent** used. Very **soluble** chemicals will move further up the chromatography paper than the less **soluble** ones. **Insoluble** chemicals will not move at all.

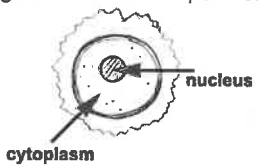
07.7 REPRODUCTION.KO.2022-23

Animal sexual reproduction

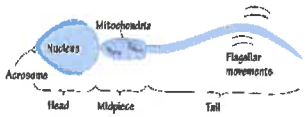
Sexual reproduction involves two individuals producing a new organism using two cells called **gametes.**

Gametes

Females make gametes called egg cells and males make gametes known as sperm cells.



Egg cell (female gamete)



Sperm cell (male gamete)

Fertilisation

When sperm cells reach an egg cell, the sperm enter the egg and the two nuclei of the cells fuse together(become one). This can occur outside the body of some animals and inside the body of others.

External Fertilisation

This is fertilisation outside the body and usually occurs in water.

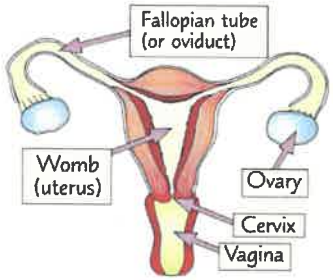
Internal Fertilisation

Fertilsation inside the body, particularly birds and mammals.

Reproductive Organs

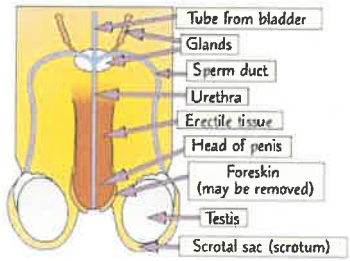
Reproductive organs produce gametes (sperm and egg cells). They form an organ system called the reproductive system.

Female reproductive system



Ovaries are where egg cells are found. Also known as ova (plural) or ovum (singular). After puberty, one ovum is released from an ovary every 28-32 days and enters the oviduct ready to be fertilised.

Male reproductive system



Sperm are made in the testes after puberty and this continues for the rest of a male's life.

Growing up

Puberty involves big body changes for an animal to reproduce. In humans, puberty starts between the ages of 10 and 15 years, with girls often starting before boys.

Changes in females during puberty



Changes in males during puberty

Menstrual cycle



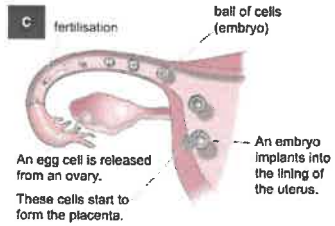
Is a series of stages in females (after puberty) where the uterus lining breaks down if the egg isn't fertilised by a sperm cell. It is controlled by sex hormones.

Becoming pregnant

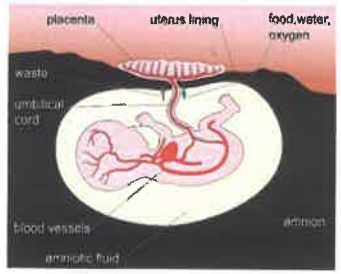
In animals that use internal fertilisation, the male must place sperm cells inside the female. Males have penises for this purpose.

Sexual intercourse

During sexual intercourse, the male's stiff penis is inserted into the female vagina. After a backwards and forwards motion, the male penis releases semen (rich with sperm) into the vagina. If a sperm cell meets an egg cell, the sperm cell can burrow into the egg and fertilise it. The fertilised egg is ready for implantation.



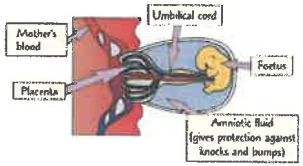
Pregnancy



After implantation the embryo (a ball of cells) continues to grow until a baby is ready to be born.

Gestation and birth

The time between fertilisation and birth is known as the gestation period and it usually lasts about 40 weeks.



Once an embryo has developed a full set of organs it is called a **foetus.** The **placenta** (a plate shaped organ attached to the uterus) lets blood of the foetus and mother get close to allow exchange of food, oxygen and wastes.

Gestational development

At 1 month- the embryo has a brain, heart,eyes, ears and legs.
At 9 weeks- the embryo is now called a foetus.
At 3 months- the foetus looks much more like a baby.
At 39 weeks- the baby is fully developed and ready to be born.

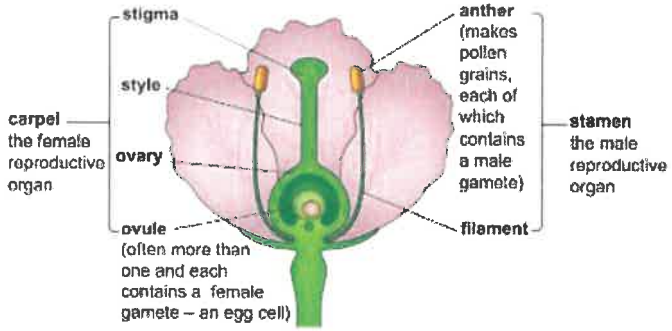
Giving birth

The uterus contracting is the start of **labour.** As **contractions** become more powerful, the amnion breaks, releasing water out of the vagina. The cervix eventually widens to 10cm and the baby is pushed out of the vagina head first. Finally, the placenta detaches itself and passes out of the vagina. This is known as, **'afterbirth'.**

07.7 REPRODUCTION.KO.2022-23

Plant Reproduction

Plants can reproduce sexually and asexually. Flowering plants reproduce sexually as they contain both male and female parts.



Flowering plants

The male gamete in a pollen grain is in the anther of a flowering plant and the female gamete egg cell is found in the ovule. Pollen grains are carried away (by wind, water or animals) and transferred to the stigma of other flowers. This is called **pollination**.

Fertilisation

When pollen grains reach the stigma of the same species, it grows a **pollen tube,** which can grow down the style and into the ovary reaching the ovule. Fertilisation of the egg cell can then occur where the male gamete nuclei fuses with the female egg nuclei. Forming a **zygote** (fertilised egg cell). The zygote goes through cell division to form an embryo. Eventually the embryo forms a tiny root and shoot.

Seed dispersal

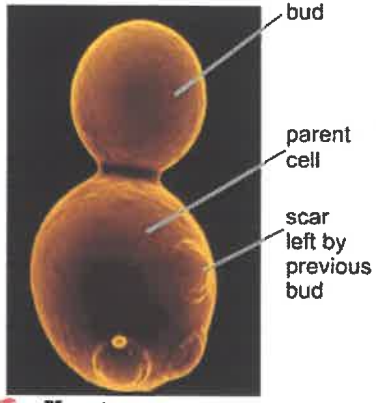
Is where fruit spreads seeds away from the parent plant. This occurs through egestion in animals, wind or water.

Asexual reproduction

Plants, bacteria and yeast can all reproduce by asexual reproduction. This does not require gametes. Instead it produces offspring that are identical to the parent.

Plants

In plant's, a parent plant forms a new plant. This means the offspring will be identical to the parent. Strawberry plants and potato plants are examples of this type of reproduction. Gardeners use this type of asexual reproduction to produce identical new plants quickly and cheaply. They take a cutting of a leaf and plant it. The cutting sprouts new roots and forms a new plant.



Yeast

Unicellular yeast use budding to reproduce. Budding is a type of reproduction where a daughter cell grows out of a parent cell.

Bacteria



Binary fission

Bacteria divide by binary fission where one cell grows and then splits into two identical cells.

07.8 PERIODIC TABLE.KO.2022-23

Group 1 reactions and equations

Reaction with water
When Group 1 metals are put in water, they react vigorously to produce hydrogen gas and metal hydroxides — substance that dissolve in water to produce alkaline solutions.
The ***general*** word equation looks like this:

Metal + Water → metal hydroxide + hydrogen

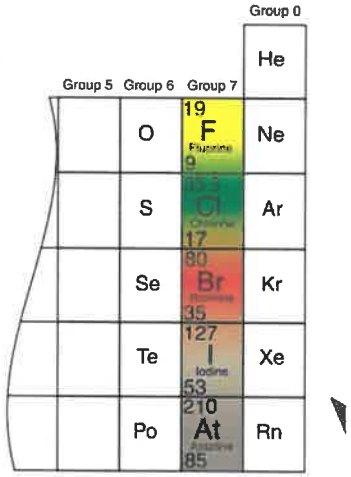
The ***general*** SYMBOL equation looks like this:

2[metal symbol] + $2H_2O$ → 2[metal symbol]OH + H_2

All the Group 1 metals react with water in a similar way.
The **more reactive** (lower down in the group) an **alkali metal** is, the more **violent** the **reaction.**
The amount of energy given out by the reaction ***increases*** down the group - the reaction with potassium releases enough energy to ***ignite*** hydrogen (*set hydrogen on fire*).

Group 7

Facts on Group 7



The elements become ***less reactive*** as you descend the group
The elements have ***higher melting*** and ***boiling points***.
The elements have ***higher*** relative ***atomic masses***.
All the Group 7 elements ***react in similar ways***. This is because ***they all have seven electrons in their outer shell***.
You can use these trends to predict properties of halogens. For example, you know that ***iodine*** will have a ***higher boiling point*** than ***chlorine*** because it is ***further down the group*** in the periodic table.

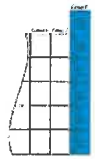
Reactions of Group 7

Group 7 elements will **react** with **compounds** containing another **halogen** as long as the **halogen** in the **compound** is **lower** in Group 7. This reaction is a **displacement reaction.**
For example
Chlorine will react with potassium **bromide** to produce **bromine** and potassium **chloride.**

Chlorine + Potassium Bromide
→
Bromine + Potassium Chloride

$$Cl_2 + 2KBr \rightarrow Br_2 + 2KCl$$

Group 0



1. ... are called the **noble gases**
2. Include the elements **helium**, **neon** and **argon**
3. All have 8 electrons in their outer energy level, except helium which has 2
4. All have **full outer shell** which is stable
5. This means they are **inert** (*they don't react with much at all*) so this means they are not **flammable**.
6. They exist as **monatomic** gases — single atoms not bonded to each other.
7. Are colourless gases at room temperature.

Atomic mass and neutrons

The middle of any atom contains ***protons*** and a particle called ***neutrons***.
Added together the protons and neutrons make a number called the **ATOMIC MASS**. This is usually written at the ***top*** of the symbol like this: ^{12}C.
To ***work out the number of neutrons***, you do a takeaway sum.
Example: Sodium (Na):

$$^{23}_{11}Na$$

Atomic Mass	-	Atomic Number	=	Neutron number
23		11		12

History of the Periodic Table

John Dalton produced a **Periodic Table** where he arranged them by **atomic mass.**
Good points – symbols to represent elements
Bad points – symbols were complicated, no space for new elements, contained some compounds, not grouped by properties. E.g.



Newland used the 'Law of Octaves' = every eighth element has similar properties
Good Points – properties repeat
Bad points – some elements not in the correct group, other scientists thought linking **science** to **music** was silly, no room for new elements.
Mendeleev arranged by **atomic mass** but rearranged if the elements were in the wrong group by **property**, he left **gaps** to ensure the elements were in the right group. He **predicted the properties** of elements which would fit in the gap.
Good points – able to **predict new elements** to fill the gaps, **predictions** were **correct**, arranged by **property**.

Modern periodic table is arranged in order of **atomic (proton) number** and so that elements with **similar properties** are in **columns.**

07.8 PERIODIC TABLE.KO.2022-23

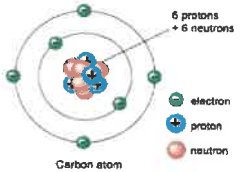
Atoms and the Periodic Table

The Periodic Table lists all the elements discovered. The modern-day Periodic Table is based on the discoveries of **Dmitri Mendeleev.**



The ***vertical columns are called groups***. The ***horizontal rows are called periods***. If you know the ***properties*** of one element in a group, you can ***predict*** the properties of other elements in that group. E.g. Group 1 elements are all soft, shiny metals which react in a similar way with water.

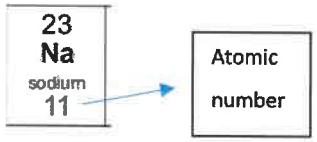
Atom structure



Electrons are tiny **sub atomic particles** which have **very little mass, negatively charged** and move in **electron shells** around the **nucleus.**
Protons are tiny **sub atomic particles** which have a **relative mass of 1**, are **positively charged** and are in the central part of the atom called the **nucleus.**

Atomic Number

The **atomic number** tells us the **number of protons** in any atom. This is the number written in the **below each symbol** for each element.



This means that Sodium has 11 protons.

For each atom

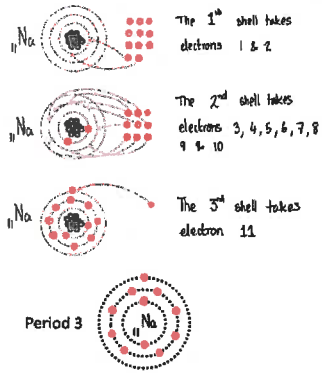
No. of protons= No. of electrons

This means Sodium has 11 electrons too.

Electron arrangement

The electrons are found in the shells or energy levels of each atom.
Rule for electrons in shells or energy levels
1st shell (energy level) =**2**
2nd shell (energy level) = **8** (max)
3rd shell l(energy level) = **8** (max)

For example



This call also be written as **2,8,1.** this is the **electron configuration.** Sodium has **3 shells** which is **equal** to its **Period number.** Sodium has **1 electron** in **its outer shell** which is **equal** to its **group number.**

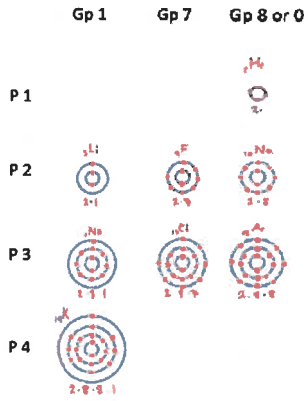
Group names in the Periodic Table

Group names you need to learn

Alkali metals- Group **1**
Halogens- Group **7**
Noble gases- Group **0**
Transition metals- block between **Group 2 and 3**

Patterns in electron structure and Periodic table
Any element in **Group 1** have **1 electron** in their **outer shell.**
Any element in **Group 7** has **7 electrons** in their **outer shell.**
Any element in **Group O** will have a **full outer shell**(needs **NO electrons** to fill its outer shell)

Outer shell
electron number = Group number



Any element in Period 2 will have two shells or energy levels like Li and F.
Number of shells= Period number

Group 1

Facts on Group 1

1. Group 1 elements are known as the **alkali metals** - these are **silvery-coloured solids** that must be **stored in oil** (and handled with tongs) because they are **very reactive.**
2. The **Alkali metals** are soft and can be **cut** with a knife.
3. The **alkali metals** are **lithium, sodium, potassium, rubidium, caesium and francium.**
4. The **alkali metals** all have low density. The first three in the group are **less dense** than water (which means they **float**)
5. They all have **one electron** in their **outer shell.** This makes them **very reactive** and gives them **similar properties**.
6. **Reactivity increases** as you **descend** the group.

